

AIR FORCE QUALIFICATION TRAINING PACKAGE (AFQTP)



**FOR
ENGINEERING
(3E5X1)

MODULE 18

CIVIL ENGINEERING DESIGN**

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Career Field Education and Training Plan (CFETP) references from 1 April 02 version.

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Supersedes AFQTP 3E5X1-17, 1 May 01

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**AIR FORCE QUALIFICATION TRAINING PACKAGES
FOR
ENGINEERING
(3E5X1)**

INTRODUCTION

Before starting this AFQTP, refer to and read the "[AFQTP Trainer/Trainee Guide](#)."

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP **does not** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:

AFQTP completion
Hands-on certification

Diamond task:

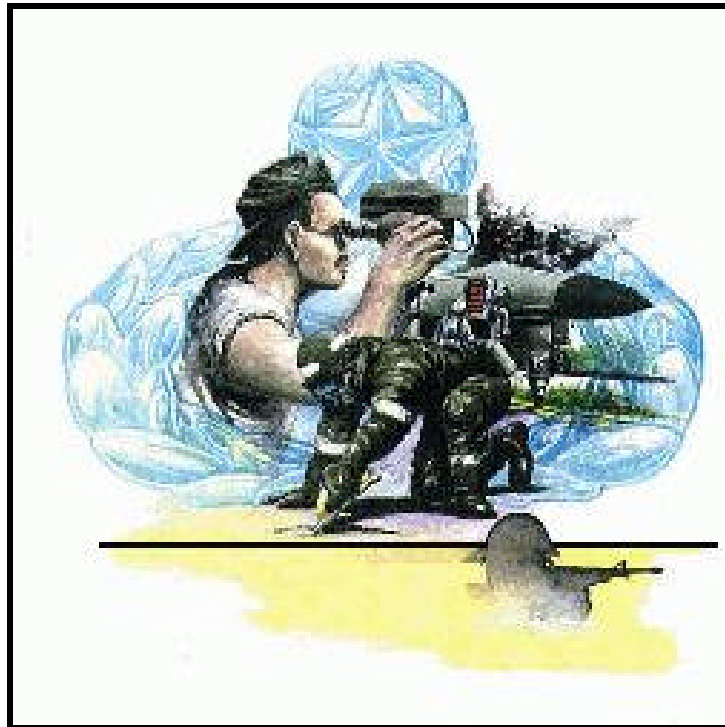
AFQTP completion
CerTest completion (80% minimum to pass)

Note: Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location.

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCEA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Career Field Manager at the address below.

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CIVIL ENGINEERING DESIGN

MODULE 17

AFQTP UNIT 6 & 7

PREPARE MATERIAL TAKE-OFFS (18.6.)

**ESTIMATE COST ELEMENTS SUCH AS: MATERIALS,
EQUIPMENT, AND LABOR (18.7.)**

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PREPARE MATERIAL TAKE-OFFS**ESTIMATE COST ELEMENTS SUCH AS: MATERIALS, EQUIPMENT, AND LABOR*****Task Training Guide***

| | |
|---|---|
| STS Reference Number/Title: | 18.6. - Prepare material take-offs. 18-7. - Estimate cost elements such as: materials, equipment, and labor. |
| Training References: | 1. R.S. Means 2002 Building Construction Cost Estimating Guide (or current version). 2. Local Procedures. 3. Career Development Course (CDC) 3E551A Engineering Journeyman, Volume 2, Unit 3, <i>Design Considerations</i> . |
| Prerequisites: | 1. Possess as a minimum a 3E551 AFSC. 2. Review the following references: 2.1. R.S. Means 2002 Building Construction Cost Estimating Guide (or current version). 2.2. Local Procedures. 3. Complete CDC 3E551B Engineering Journeyman, Volume 2, Unit 3. |
| Equipment/Tools Required: | 1. Materials Take-offs Worksheet (Similar to Element's Sample). 2. AF Form 3052, Construction Cost Estimate Breakdown. |
| Learning Objective: | 1. The trainee will be able to prepare material take-offs. 2. The trainee will be able to estimate cost elements. 3. The trainee will be able to use RS Means Estimating Guides. |
| Samples of Behavior: | The trainee will prepare material take-off and cost estimate. |
| Note: | |
| R.S. Means is only one of many vendors providing estimating guides. | |

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PREPARE MATERIAL TAKE-OFFS

ESTIMATE COST ELEMENTS SUCH AS: MATERIALS, EQUIPMENT, AND LABOR

1. Background.

1.1. Cost estimating must be performed for every Air Force construction project. Estimating is an educated analysis of all resources required to complete a project. This is nothing more than good management practices which considers the 4 Ms; methods, manpower, material and machinery. Estimating begins by establishing a bill of materials also known as a BOM. A BOM, or a materials take off, is a listing and description of the various materials and the quantities required to complete a particular construction project. The estimator must compile this BOM by consulting various references to include engineers, users, and contract documents (e.g., plans and specifications). The important thing to remember is to ensure the list is complete and accurate.

1.2. When preparing material takeoffs, keep these common sources of error in mind:

1.2.1. Drawing notes and references. Failure to read all notes on a drawing or to examine reference drawings results in many omissions.

1.2.2. Scaling drawings. Common scaling errors are using the wrong scale, reading the wrong side of a scale, and failing to note that a detail being scaled is drawn to a scale different from the rest of the drawing.

1.2.3. Interpreting specifications. Wrong interpretation of a section of the specifications can cause errors in the estimate.

1.2.3.1. Omissions. Use checklists to ensure all work elements or materials have been included in the estimate. If drawings are revised after takeoff, new issues must be compared with the copy used for takeoff and appropriate revisions made in the estimate.

1.2.3.2. Allowance for waste and loss. Failure to make proper allowance for waste and loss results in erroneous estimates. There is also the possibility of loss due to pilferage, vandalism, and weather damage.

2. Prepare Material Take-offs. Estimators must mentally picture the separate operations involved during the construction process. They read drawings and obtain accurate measurements from them. They must have a working knowledge of construction disciplines, preferably knowledge based on previous construction experience. They must be able to evaluate the effects of numerous factors and conditions affecting construction and make allowances for these. Experienced estimators have a system for efficiently progressing from the receipt of plans and specifications to the final estimated project cost. Estimating involves totaling all individual costs and establishing total estimated costs of the project, including overhead and profit.

2.1. To develop an effective material take off, follow these steps:

Step 1: Study the plans and specifications. When estimators first receive the plans and specifications for a project, they should study them thoroughly to acquaint themselves with the project and learn exactly what the designer and the specifications writer have indicated or expressed. Dimensions shown on drawings or computed from those shown on drawings are used in preference to those obtained by scaling drawing distances. When there are inconsistencies between general drawings and details, details are followed unless they are obviously wrong. If there are inconsistencies between drawings and specifications, the specifications take precedence.

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Step 2: Visit the site.

2.1. After becoming familiar with the proposed job, the estimators should visit the site of the project and consider the proposed location in relation to its surroundings. They should study the factors affecting the delivery cost of materials to the particular job, such as proximity to a freight siding and any difficulty that might be encountered in getting the materials from the freight siding to the site.

2.2. The site is cleared before construction begins. Excavated earth is disposed of after construction is underway. The site is cleared again after construction is completed. These costs should be included in your take off.

Step 3: Quantify, Prepare Material Take-offs.

3.1. The material take-offs are a systematic listing of every essential detail shown on the plans and specifications, by quantity of materials required, in the industry standard unit of measure.

3.2. A typical worksheet should have an item and reference number, description of item, computations, and total quantity of each material. (See figure 1).

NOTE:

When measuring work element quantities on a drawing, it's a good idea to begin at one side and work across to the opposite side (or top to bottom), marking with a colored pencil each particular work element as it is measured and recorded. The colored marks show the estimator what has been taken off (thus preventing duplication) and provide a means of checking for omissions.

NOTE:

After the architectural and structural drawings, the mechanical and electrical drawings are worked. If applicable, these are followed by specialty or shop drawings. In each division, the order should be (1) plans, (2) elevations, (3) details, and (4) sections; each work concurrently with notes and remarks.

NOTE:

Begin by measuring work elements of the foundation and footing plan and proceed through the basement and each succeeding floor plan of the architectural and structural drawings. All references and detail drawings that refer to a particular plan are examined and worked in conjunction with that plan. After examination of the plans, the elevations and then the details are examined one by one, and all work not previously taken off is measured and recorded. Check your Unit of Measurement during computation twice.

Figure 1. Sample: Bill Of Materials (Material Take-offs)

| # | MEANS REF # | ITEM DESCRIPTION | COMPUTATION | TOTAL |
|-----|------------------|--|---|-------------------------------|
| 1. | 021 100 104-0010 | Clear and Grub Light, trees to 6" diameter, cut & chip. | $8' \times 10' = 80' \times 100 \text{ units} = 8000 \text{ [SF / 43560 SF =]}$ | 0.2 acres |
| 2. | 033 100 130-4650 | Ground Slab, not including finish, 4" thick including forms (four uses) and reinforcing steel. | $[(8' \times 10' \times .33') / 27 = .98 \text{ CY} \times 100 \text{ units} =]$ | 97.78 CY (round to 100 CY) |
| 3. | 033 450 454-0050 | Finishing Floors Monolithic, Darby finish. | $[8' \times 10' \times 100 \text{ units} =]$ | 8000 SF |
| 4. | 031 100 110-0020 | Accessories, Anchor Bolts, nut and washer included, 1/2" diameter, 6" long. | $[2 \text{ per side} = 8 \text{ per unit} =]$ | 800 bolts |
| 5. | 061 100 128-6165 | Studs, 8' high wall, 2" x 6", pneumatic nailed. | $[24 \text{ studs per unit (18 for walls, 4 for corner nailers, 2 for door framing), } 24 \times 8' = 192 \text{ BF} \times 100 = 19200 \text{ BF / 1000} =]$ | 19.2 MBF |
| 6. | 061 100 128-5865 | Headers over openings, 2" x 6", pneumatic nailed. | $[1 \text{ header} = 6 \text{ BF} \times 100 = 600 \text{ BF / 1000} =]$ | 0.6 MBF |
| 7. | 061 100 128-6040 | Plates, untreated, 2" x 6", pneumatic nailed. | $[36' \times 2 \text{ (upper and lower plates)} = 72 \text{ BF} \times 100 = 7200 \text{ BF / 1000} =]$ | 7.2 MBF |
| 8. | 074 600 611-2500 | Plywood, Fir, rough sawn, natural finish, 3/8" thick. | $[(8' \times 8' \times 2) + (8' \times 10' \times 2) = 288 \text{ SF} \times 100 = 28800 \text{ SF / 1000} =]$ | 28.8 MSF |
| 9. | 061 100 120-7880 | Ridge Board, 2" x 6", No. 2 or better. | $[12' \times 100 = 1200 \text{ BF / 1000} =]$ | 1.2 MBF |
| 10. | 062 200 220-3350 | Fascia, 1" x 6", sterling pine. | $[24 \text{ LF per unit} \times 100 =]$ | 2400 LF |
| 11. | 062 700 775-1000 | Soffits, exterior AC plywood, 1/4" thick. | $[24 \text{ SF per unit} \times 100 =]$ | 2400 SF |
| 12. | 061 150 154-0300 | Sheathing, plywood on roof, CDX, 3/4" thick. | $[4 \text{ in } 12 \text{ pitch, } (1.67)^2 + (5)^2 = \sqrt{27.7889} = 5.27 \times 12 = 63.24 \times 2 = 126.48' \times 100 =]$ | 12648 SF |
| 13. | 061 100 120-7000 | Rafters, 4 in 12 pitch, 2"x 6". | $[5.27 \times 2 = 10.54 \times 6 = 63.24 \text{ BF} \times 100 = 6324 \text{ BF / 1000} =]$ | 6.33 MBF |
| 14. | 073 100 104-0150 | Asphalt Shingles, Inorganic; class A, 210-235 lb./sq., 3 bundles/square. | $[126.48 \text{ SF per unit} \times 100 \text{ units} = 12648 \text{ SF / 100} =]$ | 126.5 SQ |
| 15. | 073 100 104-0900 | Ridge Shingles. | $[12' \times 100 =]$ | 1200 LF |
| 16. | 076 200 202-0010 | Drip Edge, Aluminum, .016" thick, 5" wide, mill finish. | $[12' + 12' + 5.27' + 5.27' = 34.54 \text{ LF} \times 100 =]$ | 3454 LF |
| 17. | 081 100 114-1340 | Residential Door, Steel, flush face, full panel, 3'-0" x 6'-8", 24 gauge. | $[100 \text{ doors}]$ | 100 each |
| 18. | 087 100 120-0400 | Lockset, standard duty, cylindrical with sectional trim, keyed, single cylinder. | $[100 \text{ locksets}]$ | 100 each |

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3. Developing Cost Estimates. Construction cost estimates may be quite detailed depending on the intended use of the estimates. If the estimates are to be used for planning and budgetary purposes, a preliminary estimate may suffice. If the estimates are supporting a request for project approval and funds, they are computed in detail. In preparing an estimate, estimators rely on their experience, their records, and published figures. These publications may be Air Force or commercial.

3.1. Use of Means Cost Estimating Guide. The Means Cost Estimating Guide is Construction Management's primary reference for estimating. It provides valuable information on material, labor, and equipment costs associated with performing virtually all aspects of construction. Material costs are determined by consulting various product manufacturers, dealers, and distributors. The labor costs are determined by using the average wage rates from 30 major US cities. (However there are provisions for local city index multipliers) Equipment costs include rental and operating fees as required by contractors and equipment suppliers. The index in the back of the book provides a detailed, alphabetized listing of all work elements. Let's walk through an *example* of pricing an item of construction. (Reference 2002 R.S. Means Building Construction Cost Data Guide)

3.2. To properly use R.S. Means Building Construction Cost Data Guide, follow these steps (the item line numbers shown used below may change from version to version of R.S. Means). Reference the AF 3052 (figure 2) which follows step eight. The first line item is completed for you. Go through the step-by-step procedures for line item one and then complete each line item on the AF 3052. Notice the preceding BOM was used for the line items. After completion, your trainer will check and provide feedback.

Step 1: Prepare a cost estimate work sheet to compile your cost estimates data.

1.1. Use your BOM as the line items needed.

1.2. An AF 3052 is an excellent guide to use.

Step 2: Go to the index of the R.S. Means Building Construction Cost Data. There you will find the page number corresponding to your subject or item. Let's look up the first item under your BOM, clear and grub trees.

Step 3: Determine which item meets the requirements for clear and grub trees you want to estimate. Look at clear and grub cut & chip light, tress to 6" dia.

Step 4: Determine the type, size, and style needed. (The specifications will help with this information.) In this instance we don't need to look any further. We're already at the needed line item, item 021-104-0010. However, if our trees were 12" we would use line item 021-104-0200.

Step 5: Looking across from this line item, you will be given the unit of measure (Acre), Material cost (\$0), Labor cost (\$1100) and Equipment cost (\$1175). Also note the column for O&P (overhead and profit). We will discuss this column later. There is no material cost listed for the removal of trees because there are no new materials needed. However, we must note that in our BOM we only need to work on .2 acres. Therefore, our line item cost for material is (\$0), unit x material cost or .2 x \$0; labor cost is (\$220) .2 x 1100; equipment cost (otherwise know as other direct costs) is (\$235) or .2 x \$1175. Our total line item cost for this line item is \$455.00 (\$220.00+\$235.00)

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Step 6: Repeat the above process of finding the material, labor, and equipment costs for each item on your materials takeoff sheet in the means catalog. Remember you must multiply the costs of each unit by the quantity.

Step 7: Once you have completed the pricing of each entry on your materials takeoff sheet, you will need to total the project cost.

Step 8: Now that you have a project cost, you will need to factor in the costs of the contractors overhead and profit to come up with the total project estimated cost.

8.1. Overhead is all of the general expenses of operating a construction business. Generally, for estimating purposes, overhead is 15% of the estimated project cost. Multiply your project cost times 15% and add this cost to come up with a project cost plus overhead.

8.2. Profit is self-explanatory. Generally, for estimating purposes, profit is 10% of the project cost plus overhead. Multiply project cost plus overhead times 10% and add this cost to come up with the overall project cost. Note R.S. Means has a column that includes overhead and profit. For our purposes, we are not concerned with this column. Contact your trainer for local guidance using this column.

NOTE:

Because of the need for accuracy, you should check estimates in a manner that eliminates as many errors as possible. Having another person make an independent estimate and comparing the two is an excellent way to verify the accuracy of your estimate and eliminate errors.

Figure 2. Sample: Cost Estimating Worksheet

| CONSTRUCTION COST ESTIMATE BREAKDOWN | | | | | | | | | | |
|--------------------------------------|-------------|------------------------|-----------------|---------------|--------------|-------------------------|---------------------|-------------------------------|---------------------------|--------------------|
| CONTRACTOR | | | | | ADDRESS | | | | | |
| CONTRACT FOR (Work to be performed) | | | | | | | | PROPOSED TOTAL CONTRACT PRICE | | |
| PURCHASE REQUEST NUMBER | | | PROJECT NUMBER | | | | WORK LOCATION | | | |
| LINE NO. | ITEM (1) | UNIT OF MEASURE (2) | QUANTITY (3) | MATERIAL COST | | LABOR COSTS | | | OTHER DIRECT COSTS (9) | LINE TOTAL (10) |
| | | | | UNIT (4) | TOTAL (5) | MANHOURS MANDAYS (6) | AVERAGE RATE (7) | TOTAL (8) | | |
| 1 | CLR & GRB | ACRES | 0.2 | | | | 1100.00 | 220.00 | 235.00 | 455.00 |
| 2 | SLAB | CY | 100 | | | | | | | |
| 3 | FINISHING | SF | 8000 | | | | | | | |
| 4 | ANCR BOLT | EA | 800 | | | | | | | |
| 5 | STUDS | MBF | 19.2 | | | | | | | |
| 6 | HEADERS | MBF | 0.6 | | | | | | | |
| 7 | PLATES | MBF | 7.2 | | | | | | | |
| 8 | SIDING, PLY | SF | 28,800 | | | | | | | |
| 9 | RIDGE | MBF | 1.2 | | | | | | | |
| 10 | FASCIA | LF | 2400 | | | | | | | |
| 11 | SOFFITS | SF | 2400 | | | | | | | |
| 12 | SHEATHING | SF | 12,648 | | | | | | | |
| 13 | RAFTERS | MBF | 6.324 | | | | | | | |
| | SUBTOTAL 1 | | | | | | | | | |

AF FORM 3052, JAN 88

| CONSTRUCTION COST ESTIMATE BREAKDOWN | | | | | | | | | | |
|--------------------------------------|-------------|------------------------|-----------------|---------------|--------------|-------------------------|---------------------|-------------------------------|---------------------------|--------------------|
| CONTRACTOR | | | | | ADDRESS | | | | | |
| CONTRACT FOR (Work to be performed) | | | | | | | | PROPOSED TOTAL CONTRACT PRICE | | |
| PURCHASE REQUEST NUMBER | | | PROJECT NUMBER | | | | WORK LOCATION | | | |
| LINE NO. | ITEM (1) | UNIT OF MEASURE (2) | QUANTITY (3) | MATERIAL COST | | LABOR COSTS | | | OTHER DIRECT COSTS (9) | LINE TOTAL (10) |
| | | | | UNIT (4) | TOTAL (5) | MANHOURS MANDAYS (6) | AVERAGE RATE (7) | TOTAL (8) | | |
| 14 | SHINGLES | SQ | 126.48 | | | | | | | |
| 15 | RIDGE SHIN | LF | 1,200 | | | | | | | |
| 16 | DRIP EDGE | LF | 3,454 | | | | | | | |
| 17 | DOOR | EA | 100 | | | | | | | |
| 18 | LOCKSET | EA | 100 | | | | | | | |
| | | | | | | | | | | |
| | SUBTOTAL 2 | | | | | | | | | |
| | | | | | | | | | | |
| | SUB 1 & 2 | | | | | | | | | |
| | 15% OVH | | | | | | | | | |
| | SUB + OVH | | | | | | | | | |
| | 10% PROFIT | | | | | | | | | |
| | TOTAL | | | | | | | | | |

AF FORM 3052, JAN 88

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**REVIEW QUESTIONS
FOR
PREPARE MATERIAL TAKE OFFS
ESTIMATE COST ELEMENTS SUCH AS: MATERIALS, EQUIPMENT, AND LABOR**

| QUESTION | ANSWER |
|---|--|
| 1. List five places where estimating errors may occur. | Written answer. |
| 2. How can estimators fully acquaint themselves with a project? | Written answer. |
| 3. When measuring work element quantities, what is the order the drawings should be worked? | Written answer. |
| 4. Where is the information obtained for preparing material take-offs or bill of materials? | Written answer. |
| 5. Which of the following is one of the best ways to check an estimate? | <ul style="list-style-type: none">a. Have another person make an independent estimate and compare the two.b. Add all the figures backwards.c. Read through the estimate back to front.d. Wait until the contractor submits an estimate and compare the two. |

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NOTE TO TRAINER:

The performance checklist below is not restricted to the given, trainer is highly encouraged to make additions/revisions in order to facilitate this AFQTP and maximize the training objective. New performance checklist must conform within the guidelines of this specific element.

PREPARE MATERIAL TAKE-OFFS AND ESTIMATE COST ELEMENTS SUCH AS: MATERIALS, EQUIPMENT, AND LABOR

PERFORMANCE CHECKLIST

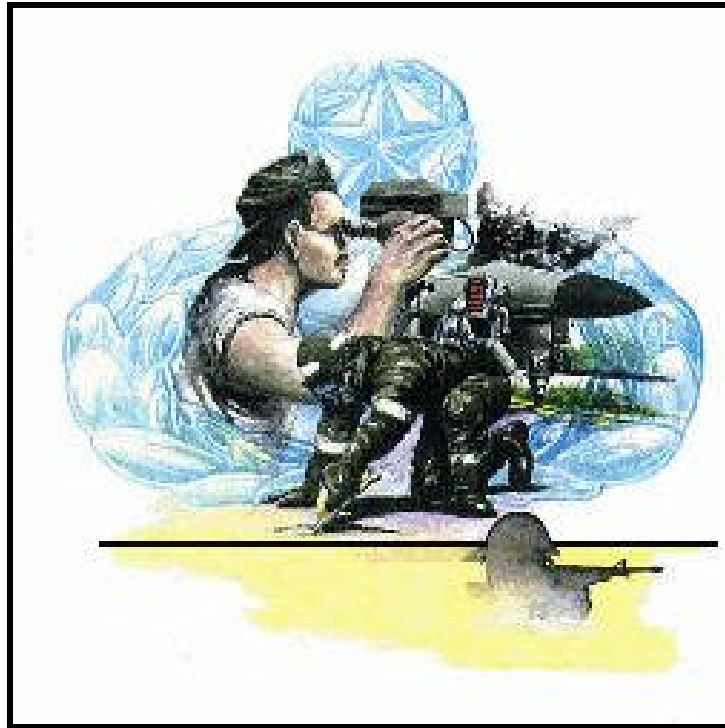
INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

| DID THE TRAINEE.... | YES | NO |
|---|------------|-----------|
| 1. complete a thorough review of the plans and specifications? | | |
| 2. make a site visit? | | |
| 3. take systematic approach to develop the materials takeoff? | | |
| 4. ensure the materials takeoff list a complete product reflecting all the materials and quantities required to complete the cost estimate? | | |
| 5. properly use the means catalog to gather cost data? | | |
| 6. properly calculate item costs taking into consideration quantities? | | |
| 7. properly add overhead and profit costs to calculate a total project cost? | | |

FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the minds of both the trainee and trainer/certifier.

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CIVIL ENGINEERING DESIGN

MODULE 18

AFQTP UNIT 8

DEVELOP WORK STATEMENTS (18.8.)

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DEVELOP WORK STATEMENTS***Task Training Guide***

| | |
|--|---|
| STS Reference Number/Title: | 18.8. - Develop (Civil Engineering Design) work statements. |
| Training References: | <ol style="list-style-type: none"> 1. Air Force Instruction (AFI) 32-1023, Design and Construction Standards and Execution of Facility Construction Projects. 2. AFI 32-1024, Standard Facility Requirements. 3. AFI 32-6002, Family Housing Planning, Programming, Design, and Construction. 4. Air Force Pamphlet (AFPAM) 32-1005, Working in the Engineering Flight. 5. Air Force Policy Directive (AFPD) 32-10, Installations and Facilities. 6. Air Force Joint Manual (AFJMAN) 32-1008, Installation Design. 7. Military Handbook 1190, Facility Planning and Design Guide. 8. Federal Acquisition Regulations (FAR). |
| Prerequisites: | <ol style="list-style-type: none"> 1. Possess as a minimum a 3E551 AFSC. 2. Review the following references: <ol style="list-style-type: none"> 2.1. AFIs 32-1023 and 32-1024. 2.2. Federal Acquisition Regulations (FAR). |
| Equipment/Tools Required: | Standard office supplies |
| Learning Objective: | <ol style="list-style-type: none"> 1. The trainee will be able to gather project requirements from user need assessments. 2. The trainee will be able to compare user needs to AF/DoD construction standards. 3. The trainee will be able to develop a work statement. |
| Samples of Behavior: | The trainee will consolidate and validate project requirements and prepare a work statement. |
| Note: | |
| <p>Work statement is not to be confused with either a Statement of Work (SOW) or a Performance Work Statement (PWS). A work statement is to be considered a listing of validated user requirements similar to what would be included in a DD 1391, Military Construction Project Data. Sample PWS are listed on the AFCESA web site: http://www.afcesa.af.mil/Directorate/CEO/Contracts/Outsourcing/PWS/Market/De</p> | |

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DEVELOP WORK STATEMENTS

1. Background. The first step in project development is the defining the requirements. This is accomplished by working closely with the user and discussing their needs. Typically the user has a list of wants that must be pared down to needs. Needs should be defined as those elements required to support the mission. The second step of developing work statements is to validate the user's needs. This is accomplished by comparing the needs to various sets of published standards. A simple example might be an individual wanting a 1200 SF office when he's only authorized 900 SF. The completed work statement is the basis for development of project plans and specifications, so the tighter the document, the less likely hood of needing amendments and modifications later in the contracting process.

2. To perform this task, follow these steps:

Step 1: All work in Civil Engineering starts with AF Form 332. This document should be reviewed to get a general sense of the project scope. The AF Form 332 should list the user's rough requirement and supporting references (AFI, AFPAM, OSHA, etc.).

Step 2: Review all other work orders related to project location. If multiple work orders or AF Form 332s have been submitted for a particular site, they need to be compared to ensure; (1) there is no duplication of effort and (2) decide if the work can be combined into one larger project.

Step 3: Interview the user. The requirements listed on the AF Form 332 are typically not detailed enough for project development. Most times the user has only a sense of what they need and depend on our experience to fill in the gaps. Again let's look at the office scenario. The AF Form 332 only lists an office, but doesn't go into details such as any required demolition, the construction materials of the new office, what the finishes will be, or is any major utility work will be required.

Step 4: Validate the user requirements. Validation means comparing the wants of the user to a standard (AFI, AFPAM, OSHA, etc.), and turning it into a need. It also means comparing the need to what the established base standards are. So for our office, the user may want a cipher lock installed, but the intended use of the office does not support the cipher lock. You'll need to recommend a normal key set. The user may also want blue wall covering, but the approved local standard is brown due to materials maintained by maintenance force. You may also find there is insufficient available power to supply the new office, and will need to bring new service to half the building.

Step 5: Develop the list of final requirements (needs). The list of requirements should only be detailed enough to define the major categories of construction required. Think through the CSI numbering scheme (0-16), pull out the major line items, and develop rough orders of magnitude. (An example would be instead of listing 930' of #10 cable, 310' of ¾" conduit, 10-junction boxes, 2-20 amp breakers, and 4-receptacles, you would list 400' of new electrical service).

Step 6: Cost estimate your final requirement list. A Rough Order of Magnitude (ROM) estimate is accomplished and presented to the user. The ROM does two things: First, it gives the user a sense of what the project budget will be. Often times the estimated amount on the AF Form 332 is much lower than actual costs. This is attributed to the user not fully understanding the entire scope of their initial wants or how the standards dictate things above and beyond the wants. Secondly, the ROM establishes how the work will be accomplished. Small projects can be completed by either self-help programs or in-house personnel. Larger projects are designed by either

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the Engineering Flight, Architect/Engineer Firms, or other governmental agencies (i.e. Army Corps of Engineers). The design avenue will also dictate the time required to accomplish the work.

Step 7: Close the loop with the user. After you've completed the list of project requirements, and created the ROM, it's time to meet the user again. The user must ensure all their needs are being met. If the budget or the estimated start and/or completion of the job are other than what the user expected you may find yourself back at the estimating board. The process of requirement definition, estimating and meeting the user is a very circular process. Only when all requirements are met, and the budget is settled, is the work statement complete.

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**REVIEW QUESTIONS
FOR
DEVELOP WORK STATEMENTS**

| QUESTION | ANSWER |
|---|---|
| 1. What are the first steps in completing a work statement? | Written answer. |
| 2. What is the difference between a want and requirement? | Written answer. |
| 3. How Detailed does the ROM get? | a. To exact quantities. b. To approximate quantities. c. To the CSI level of detail. d. As detailed as required. |
| 4. Why is it important to close the loop with the user? | Written Answer. |

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DEVELOP WORK STATEMENTS

PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

| DID THE TRAINEE.... | YES | NO |
|--|-----|----|
| 1. check all open work orders and AF Form 332s? | | |
| 2. interview the user? | | |
| 3. validate the user's request against standards and guidance? | | |
| 4. develop a final list of requirements? | | |
| 5. develop a ROM to the appropriate level of detail? | | |
| 6. close the loop with the user? | | |

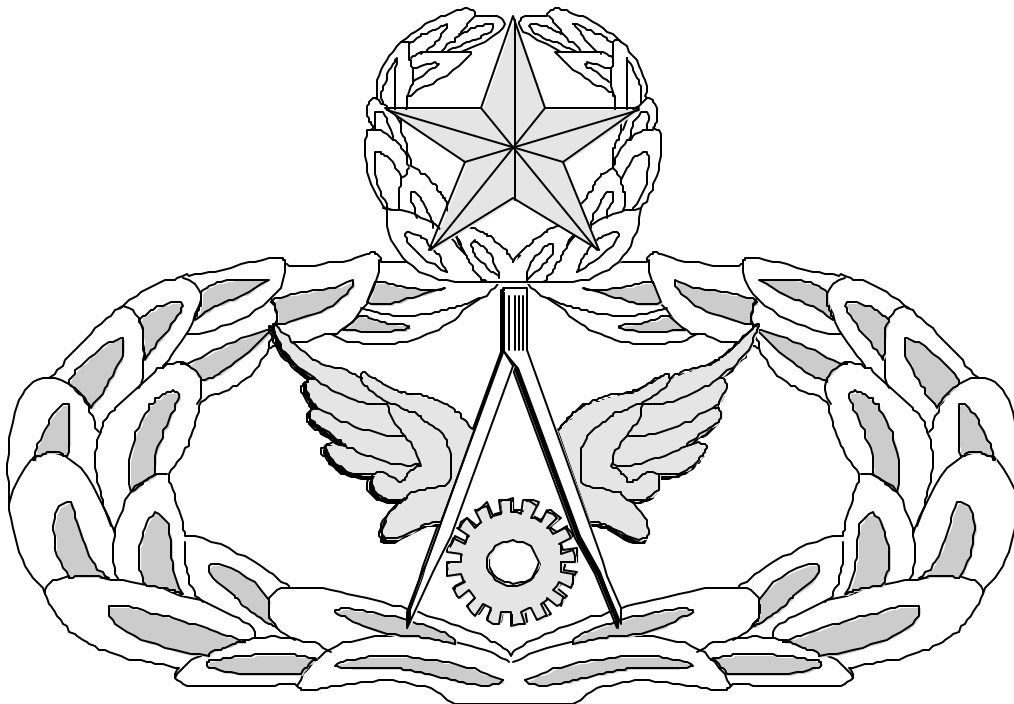
FEEDBACK: Trainer/Certifier should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer/certifier.

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Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



FOR
ENGINEERING
(3E5X1)

MODULE 18

CIVIL ENGINEERING DESIGN

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Key-1

Figure 2, Sample: Cost Estimating Worksheet (filled out)

| CONSTRUCTION COST ESTIMATE BREAKDOWN | | | | | | | | | | |
|--------------------------------------|-------------|-----------------|----------------|---------------|-----------|----------------------|------------------|-------------------------------|--------------------|------------|
| CONTRACTOR | | | | | | ADDRESS | | | | |
| CONTRACT FOR (Work to be performed) | | | | | | | | PROPOSED TOTAL CONTRACT PRICE | | |
| PURCHASE REQUEST NUMBER | | | PROJECT NUMBER | | | | WORK LOCATION | | | |
| LINE NO. | ITEM | UNIT OF MEASURE | QUANTITY | MATERIAL COST | | LABOR COSTS | | | OTHER DIRECT COSTS | LINE TOTAL |
| | (1) | (2) | (3) | UNIT (4) | TOTAL (5) | MANHOURS MANDAYS (6) | AVERAGE RATE (7) | TOTAL (8) | (9) | (10) |
| 1 | CLR & GRB | ACRES | 0.2 | | | | 1100.00 | 220.00 | 235.00 | 455.00 |
| 2 | SLAB | CY | 100 | 73.50 | 7350.00 | | 39.00 | 3900.00 | 62.00 | 11312.00 |
| 3 | FINISHING | SF | 8000 | | | | 0.28 | 2240.00 | | 2240.00 |
| 4 | ANCR BOLT | EA | 800 | 1.11 | 888.00 | | 2.43 | 1944.00 | | 2832.00 |
| 5 | STUDS | MBF | 19.2 | 540.00 | 10368.00 | | 365.00 | 7008.00 | | 17376.00 |
| 6 | HEADERS | MBF | 0.6 | 540.00 | 324.00 | | 1125.00 | 675.00 | | 999.00 |
| 7 | PLATES | MBF | 7.2 | 525.00 | 3780.00 | | 1025.00 | 7380.00 | | 11160.00 |
| 8 | SIDING, PLY | SF | 28,800 | 0.61 | 17568.00 | | 0.65 | 18720.00 | | 36288.00 |
| 9 | RIDGE | MBF | 1.2 | 540.00 | 648.00 | | 875.00 | 1050.00 | | 1698.00 |
| 10 | FASCIA | LF | 2400 | 0.70 | 1680.00 | | 0.87 | 2088.00 | | 3768.00 |
| 11 | SOFFITS | SF | 2400 | 0.50 | 1200.00 | | 1.04 | 2496.00 | | 3696.00 |
| 12 | SHEATHING | SF | 12,648 | 0.58 | 7335.84 | | 0.36 | 4553.28 | | 11889.12 |
| 13 | RAFTERS | MBF | 6.324 | 540.00 | 3414.96 | | 435.00 | 2750.94 | | 6165.90 |
| | SUBTOTAL1 | | | | 54556.80 | | | 55025.22 | 297.00 | 109879.02 |

AF FORM 3052, JAN 88

| CONSTRUCTION COST ESTIMATE BREAKDOWN | | | | | | | | | | |
|--------------------------------------|------------|-----------------|----------------|---------------|-----------|----------------------|------------------|-------------------------------|--------------------|------------|
| CONTRACTOR | | | | | | ADDRESS | | | | |
| CONTRACT FOR (Work to be performed) | | | | | | | | PROPOSED TOTAL CONTRACT PRICE | | |
| PURCHASE REQUEST NUMBER | | | PROJECT NUMBER | | | | WORK LOCATION | | | |
| LINE NO. | ITEM | UNIT OF MEASURE | QUANTITY | MATERIAL COST | | LABOR COSTS | | | OTHER DIRECT COSTS | LINE TOTAL |
| | (1) | (2) | (3) | UNIT (4) | TOTAL (5) | MANHOURS MANDAYS (6) | AVERAGE RATE (7) | TOTAL (8) | (9) | (10) |
| 14 | SHINGLES | SQ | 126.48 | 26.00 | 3288.48 | | 35.00 | 4426.80 | | 7715.28 |
| 15 | RIDGE SHIN | LF | 1,200 | 0.72 | 864.00 | | 0.58 | 696.00 | | 1560.00 |
| 16 | DRIP EDGE | LF | 3,454 | 0.20 | 690.80 | | 0.55 | 1899.70 | | 2590.50 |
| 17 | DOOR | EA | 100 | 193.00 | 19300.00 | | 29.00 | 2900.00 | | 22200.00 |
| 18 | LOCKSET | EA | 100 | 64.50 | 6450.00 | | 22.00 | 2200.00 | | 8650.00 |
| | SUBTOTAL2 | | | | 30593.28 | | | 12122.50 | 0.00 | 42715.78 |
| | SUB 1& 2 | | | | 85150.08 | | | 67147.72 | 297.00 | 152594.80 |
| | 15% OVH | | | | | | | | | 22889.22 |
| | SUB + OVH | | | | | | | | | 175484.02 |
| | 10% PROFIT | | | | | | | | | 17548.40 |
| | TOTAL | | | | | | | | | 183761.12 |

AF FORM 3052, JAN 88

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PREPARE MATERIAL TAKE-OFFS
(3E5X1-18.6.)

ESTIMATE COST ELEMENTS SUCH AS: MATERIALS, EQUIPMENT, AND LABOR
(3E5X1-17.7.)

| QUESTION | ANSWER |
|--|---|
| 1. List five places where estimating errors may occur. | Drawing notes and references, scaling drawings, interpreting specifications, omissions, and allowances for waste. |
| 2. How can estimators acquaint themselves fully with a project? | By thoroughly studying the plans and specifications. |
| 3. When measuring work element quantities, what is the order that the drawings should be worked? | A good idea is to begin at one side and work to the opposite side. |
| 4. Where is the information obtained for preparing material take-offs or bill of materials? | Construction drawings and specifications are the main basis for preparing material take-offs. |
| 5. Which of the following is one of the best ways to check an estimate? | a. Have another person make an independent estimate and compare the two. |

DEVELOP WORK STATEMENT
(3E5X1-18.8.)

| QUESTION | ANSWER |
|---|--|
| 1. What are the first steps in completing a work statement? | Reviewing all the work orders pertaining to the facility. |
| 2. What is the difference between a want and requirement? | A want is the user's invalidated request; a requirement has been validated against a standard. |
| 3. How Detailed does the ROM get? | (b) To approximate quantities. |
| 4. Why is it important to close the loop with the user? | To ensure all the user's requirements are met, the budget works, and the work can be done with the correct timeline. |

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MEMORANDUM FOR HQ AFCESA/CEOF
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319

FROM:

SUBJECT: Qualification Training Package Improvement

1. Identify module.

Module # and title _____

2. Identify improvement/correction section(s):

| | |
|---------------------------------|-----------------------------|
| _____ STS Task Reference | _____ Performance Checklist |
| _____ Training Reference | _____ Feedback |
| _____ Evaluation Instructions | _____ Format |
| _____ Performance Resources | _____ Other |
| _____ Steps in Task Performance | |

3. Recommended changes--use a continuation sheet if necessary.

4. You may choose to call in your recommendations to DSN 523-6322 or FAX DSN/Commercial 523-6488 or (850) 283-6488 or email ceof.helpdesk@tyndall.af.mil.
5. Thank you for your time and interest.

YOUR NAME, RANK, USAF
Title/Position